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Ordovician Batophoreae (Dasycladales) from Michigan

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ABSTRACT

Archaeobatophora typa n. g. and sp. of the Upper Ordovician, Richmondian Big Hill Limestone from Delta County, Michigan, is described as a member of the Dasycladaceae. Although this alga is only weakly calcified along its main axis, its morphology is unusually well preserved and allows assignment to the extant tribe Batophoreae.

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INTRODUCTION

Fossil calcareous dasyclads are known throughout most of the Paleozoic, and, although rare in the Ordovician, they are geographically widespread. The non-calcareous dasycladaceous algae, however, are extremely rare in the fossil record and have not been unequivocally reported from the Paleozoic. The alga described in this paper is very unusual because its thallus consists of a weakly calcified main axis and well-preserved non-calcareous branches. The preservation of branches is so good that the nature and position of laterals in the whorls allows undoubted assignment to the living tribe Batophoreae.

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Order Dasycladales Pascher, 1931

Discussion—In the past there was a lack of consensus as to the taxonomic position of the Dasycladales. Thus, for example, Taylor (1960), Fritsch (1948), Levring et al. (1969), and Nitecki (1970a) placed dasycladaceous algae among Siphonocladales. However, particularly since the publication of Egerod's (1952) revision of the complex, algologists accept Dasycladales as an independent order of Chlorophyta. Among paleontologists, Johnson (particularly 1961; Johnson et al., 1959) was an early proponent of the ordinal status of Dasycladales. Many paleontologists followed Johnson's assignment (e.g., Rezak, 1971 and earlier; Elliott, 1972 and others; Nitecki, 1970b and later).

Family Dasycladaceae Kützing, 1843

Discussion—The order Dasycladales has been considered to have either one or two families. The traditional text-book account has been of one family (Bold, 1967); however, in the recent monographic treatment of the order Valet (1968, 1969) has strongly argued for the restablishment of two families, Dasycladaceae and Acetabulariaceae. His classification of Dasycladales is as follows:

Order Dasycladales
- Family Dasycladaceae
  - Subfamily Dasycladoideae
    - Tribe Dasycladeae
      - *Dasycladus*
      - *Chlorocladus*
    - Tribe Batophoreae
      - *Batophora*
  - Subfamily Bornetelloideae
    - *Bornetella*
  - Subfamily Neomeridoideae
    - Tribe Neomerideae
      - *Neomeris*
    - Tribe Cymopolieae
      - *Cymopolia*
- Family Acetabulariaceae
  - Tribe Halicoryneae
    - *Halicoryne*
  - Tribe Acetabularieae
    - *Acetabularia*

Since the fossil Dasycladales have not been recently monographed, there is no consensus as to how many tribes exist. For example, Pia (1927) recognizes 15 tribes; however, Korde (1963) recognizes only 13. According to Pia, the tribe Dasycladeae consists of three living genera, *Dasycladus, Batophora,* and possibly *Chlorocladus;* the last, however, may be considered to belong among the Neomereae. Pia places *Bornetella* in the tribe Neomereae. Korde does not discuss these genera.

Receptaculitids have been assigned various ranks among algae. I have been among the strongest proponents of the dasyclad nature of receptaculitids; however, I presently believe that although they are within the green siphonous complex and related to the Dasycladales, they are an independent order of Chlorophyceae. The best known Paleozoic green algae, cyclocrinitids, for a long time also considered Dasycladales, are now, together with other receptaculitids, removed from the dasycladaceous taxon.

Subfamily Dasycladoideae Valet, 1969

Definition—Plants with whorls all similar and simple, with perhaps only the axis calcified; with fertile ampules terminal, without cysts or pleurocysts, or with numerous ampules subterminal and with pleurocysts (Valet, 1969, p. 577).

Discussion—This subfamily and Bornetelloideae consist of species that are not (or are only weakly) calcified and therefore are not likely to be fossilized. I have observed weak calcification of the main axis in *Dasycladus clavaeformis* and the weak calcareous cortex in *Bornetella sphaerica.*

Tribe Batophoreae Valet, 1969

Definition—Thallus up to 25 cm. long; gregarious; non-calcified or weakly calcified along main axis; axis thin, long, in the adult frequently basally naked, sometimes constricted; whorls relatively far apart; branches packed in loose whorls; laterals divided up to the seventh degree with the last three to seven laterals hair-like, deciduous; fertile ampules clustered around bases of second to fifth degree laterals; Ordovician to Recent; marine to fresh waters.

Discussion—Valet (1969) included only *Batophora* in the tribe. *Archaeobatophora* is thus the second genus of the tribe.

Archaeobatophora new genus

Name—The name *Archaeobatophora* is given in recognition of the similarity of this genus to the living *Batophora,* and for its age.

FIG. 1. *Archaeobatophora typa* n.g. and sp. FMNH PP 18122. Richmondian, Big Hill Limestone (Ordovician). Delta County, Michigan.

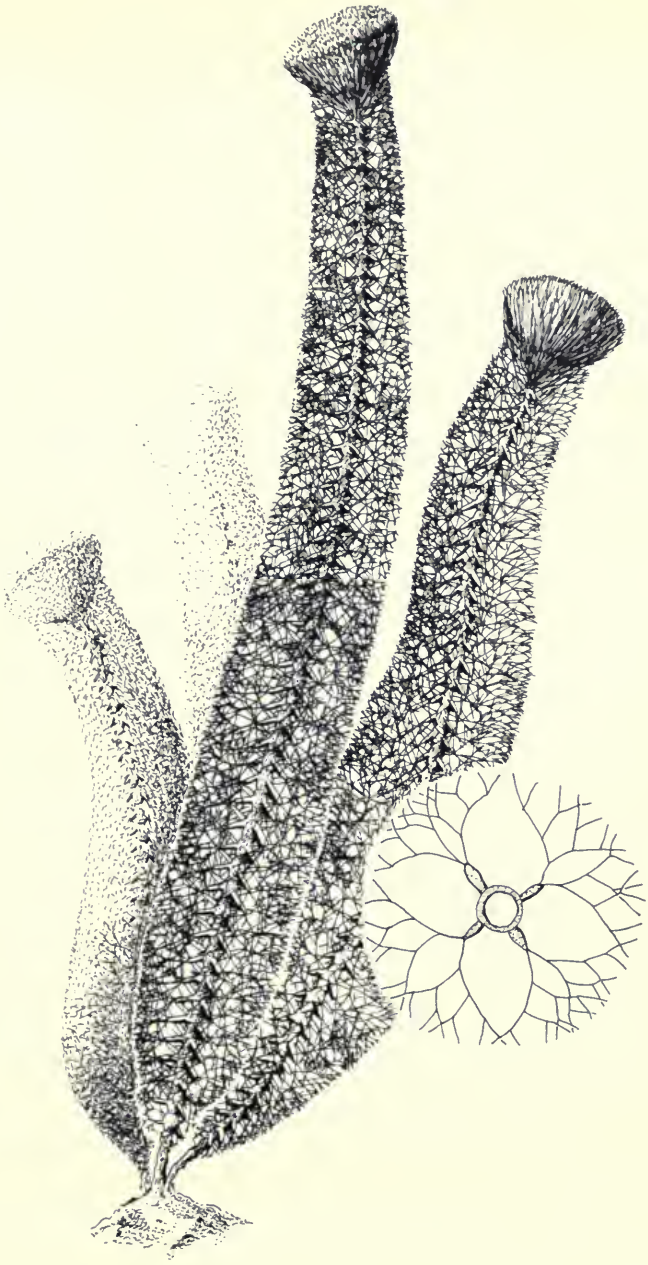

FIG. 2. Reconstruction of *Archaeobatophora typa* n.g. and sp. The holdfast is conjectural. Inset: cross-section through thallus.

Definition—As for the species.

Archaeobatophora typa n.sp. Figures 1, 2.

Definition—Thallus delicate, 5-9 cm. tall, about 1 cm. in diameter; growing in a cluster from a common base; main axis up to 0.1 cm. in diameter, with constriction between whorls; whorls of four branches, which bifurcate two to four times; primaries very short and stout; secondaries and subsequent branchlets hair-like; terminal tuft of hair dense and conspicuous; weak calcification of main axis only.

Description—The three almost complete thalli originating from a common central area suggest that the plant is gregarious. Although the details of the holdfast are unclear, it is certain that the individual thalli are all held together. In the reconstructed figure the holdfast is conjectural. The thallus consists of a central axis, whorls of branches and dense tufts of apical hair. No calcification other than along the main axis can be observed. The longest thallus is about 9 cm. long.

The main axis is very characteristic of siphonous Chlorophyta. The hollow wall of the vesicle is 0.03 cm. thick and is regularly constricted between the whorls. The whorls consist predominantly of four branches. The first-degree branch is short and relatively thick. The successive branches are hair-like. The laterals always bifurcate and frequently, but not always, branch to the fourth degree. The first-degree lateral is about 0.1 cm. long. The longest hair-like laterals may reach over 0.5 cm. in length. The apical tuft of hair is pronounced and is formed in a manner similar to that of the living dasycladacean *Cympolia barbata.*

Relationships—The recent *Batophora* are shown in Figures 3-5. The herbarium specimens are particularly suitable for comparison with fossils, because their preservation as flattened specimens is similar to the preservation of fossils.

Archaeobatophora differs from the extant *Batophora* in the following ways:

1. The axis of *Archaeobatophora* is weakly calcified and constricted between the whorls. In *Batophora* the equally thin and long axis is unconstricted and uncalcified.
2. The whorls are closer together in *Archaeobatophora* than in the living form, where the branches within the whorls and the whorls themselves are less densely packed.

FIG. 3. *Batophora oerstedi* var. *occidentalis* (Harvey) Howe. Field Mus. Crypt. Herb. 962773. Phyc. Bor.-Amer. 667. In lagoons, Island of St. Croix.

3. The basal portion of the axis is naked in *Batophora,* while in the fossil the lower branches are preserved.
4. All the laterals in *Batophora* are thin and may branch to the seventh degree. In *Archaeobatophora* the first degree laterals are short and stout and the branch divides to the fourth degree only.

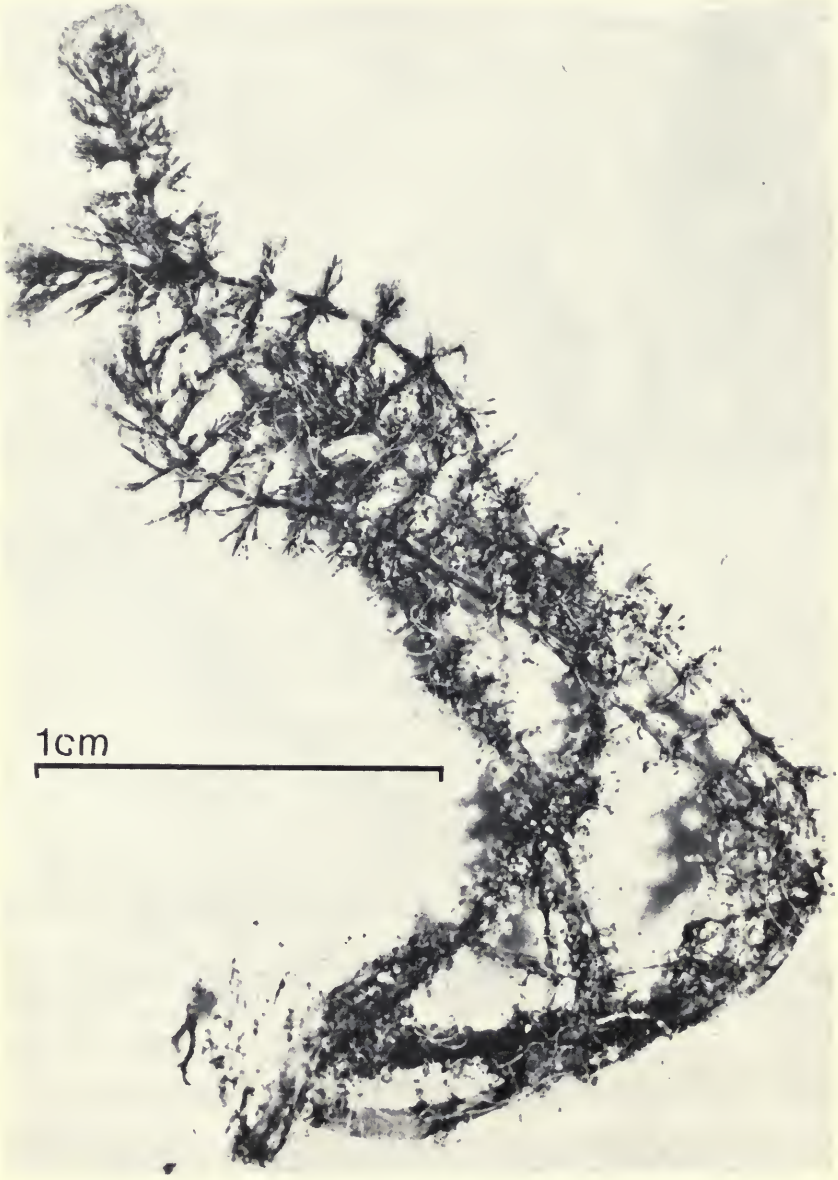

FIG. 4. *Batophora oerstedi* var. *occidentalis* (Harvey) Howe. Field Mus. Crypt. Herb. 1326895. Adams Beach, Taylor County, Florida.

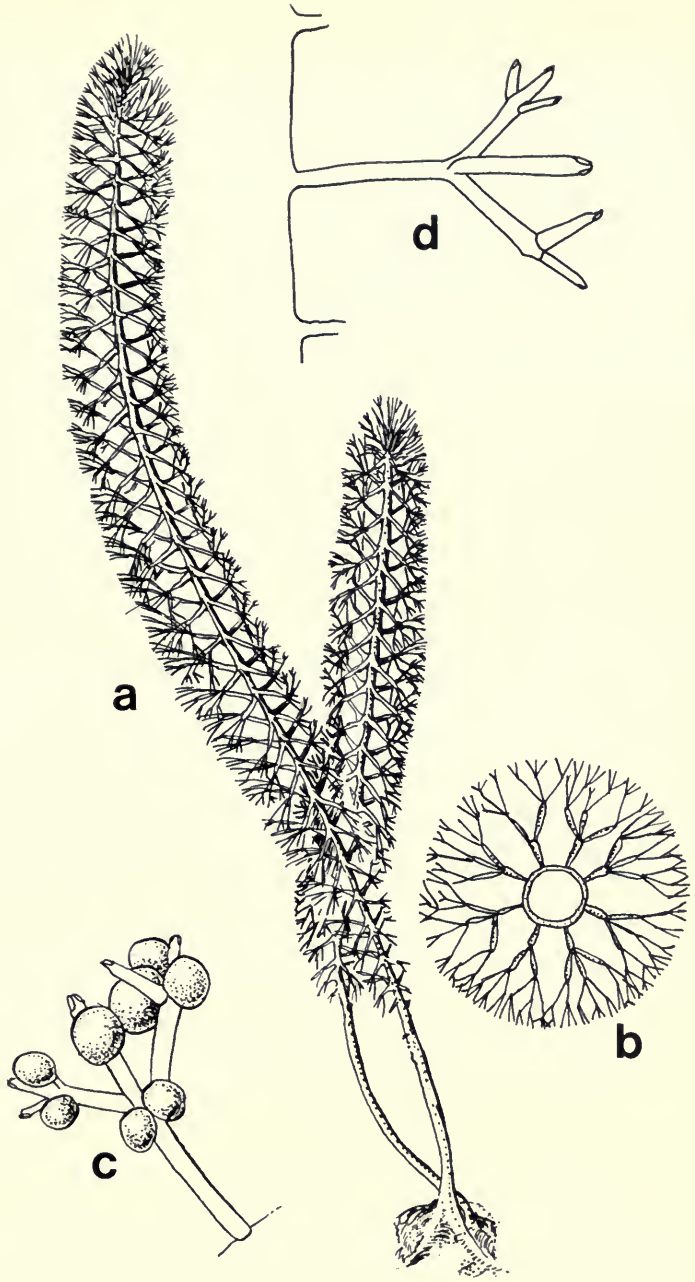

FIG. 5. *Batophora oerstedi* J. Agardh, from Bermuda. **a**, thallus; **b**, cross-section through thallus; **c**, position of gametangia; **d**, position of branch (without terminal hairs) upon main axis. Drawing based upon Gilbert Morgan Smith Herbarium 98 and 50, in Hopkins Marine Station, California.

5. The apical tuft of hair is pronounced in *Archaeobatophora,* while in *Batophora* it is either absent or inconspicuous.

It is hard to compare fossil Dasycladales with living ones. The fossils are known from skeletal remains only, and their gametangia are unknown. There are great gaps in their stratigraphic distribution, making phylogenetic reconstruction very difficult. Lower Paleozoic dasycladaceous algae are poorly known. Present knowledge of the Ordovician and Silurian Dasycladales, other than cyclocrinitids, is summarized by Johnson (1961). However, no monographic work is available on this group, and without detailed study of other Ordovician taxa comparison with other genera is difficult. *Archaeobatophora typa* may be considered somewhat related to *Chaetocladus;* however, there is very little similarity between *Archaeobatophora* and the described species of *Chaeotocladus.* The size and shape of the thalli and the nature and distribution of branches of these two genera are not closely comparable. The most that can be said about *Chaeotocladus* is that it is possibly a dasycladaceous alga.

Whitfield (1894) originally based the genus *Chaetocladus* upon the Trenton specimen from Platteville, Wisconsin. Although he placed it among algae, he did not (as stated by Johnson et al., 1959, p. 68) compare it with living Dasycladales. Ruedeman (1909) compared *Chaetocladus* with red algae. Høeg and Kiaer (1926) were uncertain of the position of the genus among the algae. Pia (1927) considered it a possible dasyclad, although he placed the genus in Algae *incertae sedis.* In 1928 Pia was less certain of the taxonomic position of *Chaetocladus,* but nevertheless considered it related to Dasycladales. Seward (1931) believed the genus to represent an uncalcified siphonous alga. Wilson (1948) assigned the genus to Algae without any further subdivision. Johnson et al. (1959) and Johnson (1961) assigned it doubtfully to brown algae. *Chaetocladus* is known from the Ordovician "Trenton" and Cobourg strata and from the Silurian Ludlow. It has been found in Wisconsin, New York, and Norway.

Callithamniopsis and *Primicorallina* are too poorly known to warrant comparison with *Archaeobatophora.*

Holotype—The tallest of the three individuals on a limestone slab; the slab is PP 18122 in Field Museum of Natural History. No other material is known.

Stratigraphic position—Upper Ordovician: Richmondian; Big Hill Limestone exposed in a new (1973) quarry that cuts through

about 30 ft. of predominantly dolomitic limestone with few fossils. The only other fossils visible on the same bedding plane are poorly preserved nautiloid orthocones and half of a rather large trilobite (*Isotelus* sp.). In the associated beds probable algal mat structures and mud-cracked, glauconitic beds are fairly common. Together with the underlying stratigraphic units of the area, these suggest the terminal phase of a long marine regression.

Location—Quarry on the west side of Delta County Route 511, about 8 miles south of Ensing, Michigan on U.S. 2. Just southwest of stop no. 8, Michigan Geological Society 1950 Excursion (Hussey, 1950, p. 21), sec. 11, T39N, R21W, Delta County, Michigan. Collected by Mr. and Mrs. Thomas R. Weaver, 1973.

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